Lake Warren

Comprehensive Lake Inventory
And
Management Plan

Photo by Lisa Tusveld

Alstead, New Hampshire

May 2012

Prepared by Southwest Region Planning Commission
and
the Lake Warren Management Plan Committee

LAKE WARREN: COMPREHENSIVE LAKE INVENTORY AND MANAGEMENT PLAN

TABLE OF CONTENTS

MAPS:

APPENDIX:

INTRODUCTION

PURPOSE

The purpose of this document is to establish and maintain a Lake Management Plan to preserve and enhance the multiple values that Lake Warren offers to the citizens of Alstead. This document consists of a Comprehensive Lake Inventory (CLI) which sets a baseline profile of the lake, and a Lake Management Plan which includes the CLI and uses it to guide on-going actions to maintain and, as necessary, improve the quality of the lake. The term "lake quality" is meant to encompass not only water quality, but all its valuable assets such as the fish and other wildlife, natural beauty, and accessibility.

The Comprehensive Lake Inventory was assembled through local surveys by members of the Lake Warren Association; a program of lake and tributary water quality sampling of 13 consecutive years; and information available through various departments of the State of New Hampshire. This baseline information includes the natural and recreational assets of the lake, the currently perceived threats to lake quality, and water quality trends over the past ten years.

The Lake Management Plan will affect users of the lake, property owners around the lake, and potentially all residents who live within the watershed of Lake Warren. It aims to identify threats to lake water quality; to help users understand how individual actions can bring about changes to the lake, both negative and positive; and to find ways to help residents, farms and businesses efficiently reduce or eliminate any negative impacts. Lake Warren is a shared resource and will require shared stewardship. Because Lake Warren's watershed lies entirely within the Town of Alstead these aims are within the capability of the residents of the town. By including this Lake Management Plan as part of the Alstead Master Plan, land use decisions can be carefully considered to provide maximum protection of the lake. This plan contains and will maintain a series of goals, objectives, and actions designed to achieve those goals.

BACKGROUND

This initiative springs from several factors. One is the larger community's high regard for natural systems and the benefits they bring. Next is the on-going work of the Cold River Local Advisory Committee in addressing water quality across the entire Cold River watershed – of which Lake Warren and its watershed are an important part. Another is the result of the past thirteen years' worth of water sample data in Lake Warren and tributary brooks, which reveal a decline in quality, and indeed a rate of decline that is much faster than the natural progression of lakes and ponds of its size, and one that calls for a purposeful and active response. The water quality analysis at the end of this plan indicates that Lake Warren is aging at a rate that is faster than expected. Still another is the value that Lake Warren provides to the people of the town, including recreational use, a good source of tax revenue, and the scenic and natural views that all can enjoy.

FUNDING SOURCE

Funding for this Comprehensive Lake Inventory and Management Plan is provided by the New Hampshire Department of Environmental Services (NH DES) through a grant from Section 604(b) of the Clean Water Act.

ACKNOWLEDGEMENTS

Thanks to the following organizations for their support in this effort:

Alstead Board of Selectmen
Alstead Conservation Commission
Alstead Planning Board
Cold River Local Advisory Committee
Connecticut River Watershed Council
KROKA Expeditions
Monadnock Conservancy- Monadnock Community Conservation Partnership
NH Department of Environmental Services
NH House Committee on Environment and Agriculture
NH Lakes Association
Southwest Region Planning Commission

This project was coordinated by Lisa Murphy, Senior Planner at Southwest Region Planning Commission, and Joyce Curll, President of the Lake Warren Association. Special thanks to Jacquie Colburn, Lakes Coordinator at the New Hampshire Department of Environmental Services (NH DES) for her advice and technical expertise.

Special thanks are also offered to David Deen for instilling inspiration in us to develop this plan, to Kate Morgan for her 13 years of tireless water testing, to Mike Heidorn for his work in water testing and analysis of those years of data, to Jeff Littleton of Moosewood Ecological and Sarah Webb for their educational talks to townspeople and Lake Warren Association members on wildlife, birdlife and plants in the environs of the lake. Thanks also to past Presidents Sharon Spaulding, Tom Dowling, and David Hogan for fostering and shepherding the Lake Warren Association to the point that such a plan is possible, and to past and current Lake Host coordinators Julie Hogan and Irene Cheek and to Weed Watching coordinators Phil and Romie Sanford for monitoring the lake over the years so that it is free of invasive weeds. Many others also participated in a variety of ways, answering surveys, helping with the water testing efforts, collecting information for the Comprehensive Lake Inventory and providing advice and expertise as the plan took shape. In addition to the Lake Warren Management Work Group, listed below, we thank Marie Bender, Marilou Blaine, Rose Marie Dowling, Jim Gruber, Evan (Bill) Jahos, Kate Koster, Jackie Lyon, Weldon Mattson and David Moody.

Lake Warren Management Plan Work Group:

Greg Bath, Ellen Chase, Dan Curll, Joyce Curll, David Deen, Mike Heidorn, Karyn Kaminsky, Theresa Lalak, John Mann, Bruce Montgomery, Nan Montgomery, Kate Morgan, Bill O'Meara, Jeff Putnam, Phil Sanford, Romie Sanford, Lisa Tusveld, Alex Ventura, and Sarah Webb

COMMONLY USED TERMS IN THIS PLAN

Conductivity: The ability of water to carry an electrical current. Increases in conductivity are usually due to human activity such a road salt runoff, septic systems, and agricultural runoff.

Invasive Species: A plant or animal species that is not native to the region. They often spread at a rapid pace and cause damage to the land and waters that native plants and animals need to survive.

Littoral Zone: The area of a lake near the shore where sunlight penetrates to the sediment and allows plant growth.

Secchi Disk Transparency: A measure of water clarity based on the depth one can see into the water. A reading of 4-15 feet is considered a good reading.

Total Phosphorus: A measure of all the phosphorus forms present in the water, including both organic and inorganic forms. Excessive amounts of total phosphorus may cause an increase in rooted plant growth which can impair the aesthetics and recreational use of the lake.

Turbidity: A measure of the degree to which the water loses its transparency due to the presence of suspended particulates.

Trophic Classification: A method of classifying lakes and ponds based on nutrient richness. There are three classifications: Oligotrophic, Mesotrophic, and Eutrophic.

> **Oligotrophic**: Lakes that are usually nutrient poor and do not support algal blooms or extensive rooted plant growth. This is the best classification of the three, and usually is found in larger and deeper lakes.
> **Mesotrophic**: This is an intermediate classification between Oligotrophic and Eutrophic. Mesotrophic lakes usually have moderate algal production. The water clarity and phosphorus input is intermediate compared to Oligotrophic and Eutrophic lakes and ponds.
> **Eutrophic**: These waterbodies, usually ponds, are often smaller and shallower, with mucky bottoms. They usually have a high production of algae and aquatic plants, which indicates an overabundance of phosphorus.

Trophic Data: The data collected and analyzed to determine the Trophic Classification of a lake or pond. This data includes: pH, acid neutralizing capacity (ANC), dissolved oxygen at lake bottom (BTTM DO), Chlorophyll-a (CHL-A), color, conductivity, plants, secchi, and total phosphorus (TP).

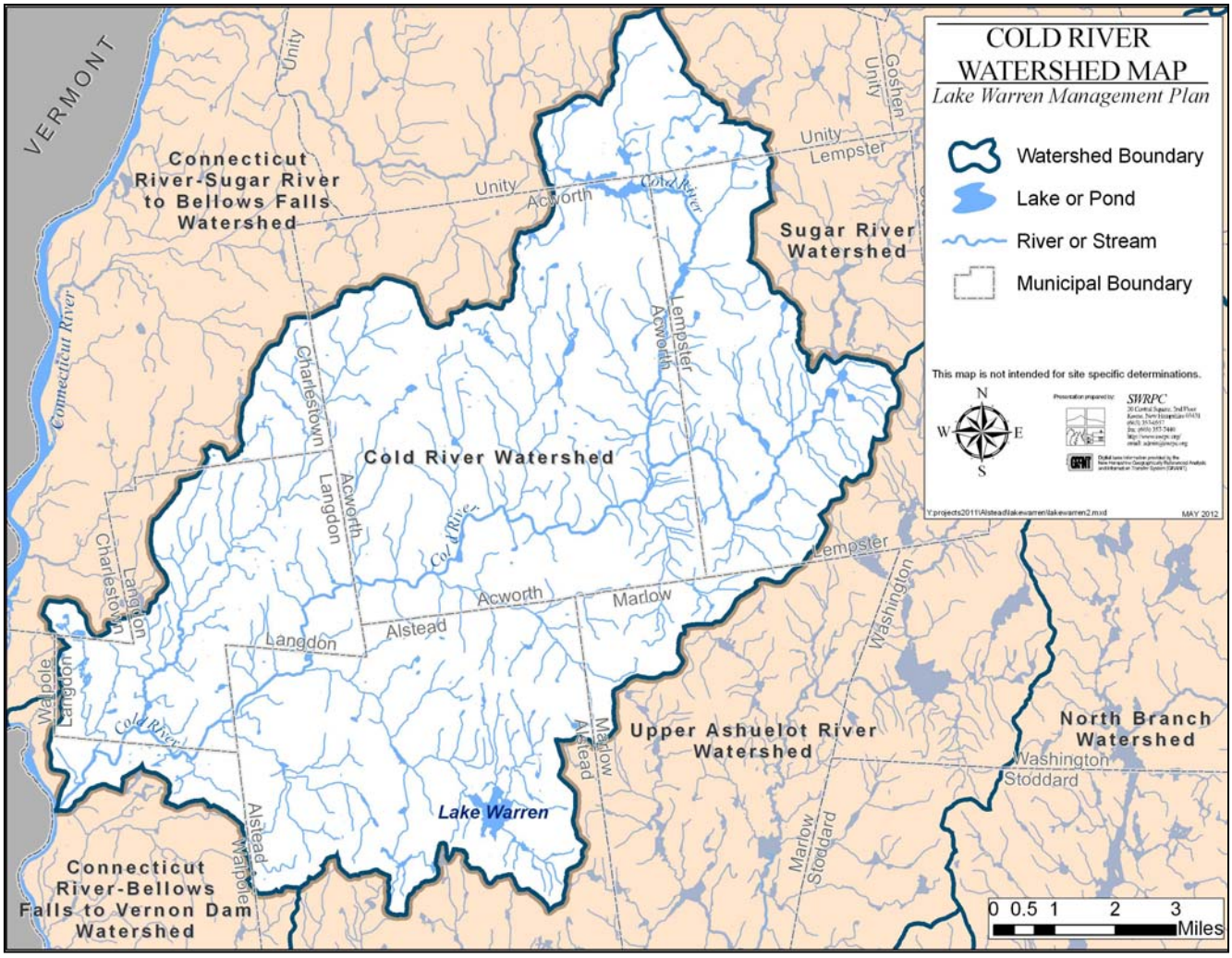
Watershed: All land that drains into a waterbody. Any activity within the watershed could have an effect on the water quality of the waterbody. Therefore best management practices should be used for all activity occurring within the watershed.

> **Sub watershed**: A smaller portion of the entire watershed of a lake or other waterbody.

GEOGRAPHIC LOCATION AND PROFILE

Lake Warren is located in the Southwestern portion of New Hampshire in the Town of Alstead, in Cheshire County (Map 1). The population of Alstead is 1,937 according to the 2010 Census data. The town has an area of 39.7 square miles of land and .4 square miles of inland waters. The Cold River and Warren Brook flow through the northern part of Alstead and join together east of the village center. The two largest ponds are Lake Warren (also known as Warren Lake) in the east and Caldwell Pond in the south. Lake Warren is accessible from NH 123. It is 185.5 acres and is a relatively shallow lake with a maximum depth of 13.8 feet and a mean depth of 7.2 feet. The entire watershed for Lake Warren lies within the Town of Alstead.

MAP 1
COLD RIVER WATERSHED MAP



METHODOLOGY

The Lake Warren Comprehensive Lake Inventory (CLI) and Management Plan was developed using guidelines set forth in the *New Hampshire Comprehensive Lake Inventory 2010, 3rd edition (NH CLI)* prepared by the NH DES Lakes Management and Protection Program. The NH CLI was used in conjunction with its companion document *The New Hampshire Guidelines for Coordinated Lake Management and Shoreland Protection Plans*.

The NH CLI is organized into ten primary attributes. Each attribute is designed to address a specific characteristic commonly evaluated when developing a lake management plan. Within each attribute there is a series of questions and a listing of multiple-choice answers for each question. A score has been assigned to particular questions to ascertain each of these values as follows:

1) Recreational Value, ranked from 1 – 5, with 1 being the lowest level of recreational value and 5 being the highest level of recreational value.
2) Susceptibility to Impairment, ranked from 1 – 5, with 1 being the lowest level of susceptibility and 5 being the highest level of susceptibility.

There are 20 questions associated with each attribute (Recreational and Susceptibility to Impairment). After completing the survey, the score is determined by adding the scores of the applicable questions resulting in a total of 100 possible points for each attribute. This scoring system was designed to provide an evaluation technique that can be easily understood by all users. The *real* value that should be gained from this technique is in the information collected rather than the actual score. Ultimately, the information collected will help to create a long-term vision for the management of the lake and maintain the water quality of this valuable resource in Alstead.

ASSESSMENT OF RECREATIONAL ATTRIBUTES

The Lake Warren CLI focuses on *recreational values* and *susceptibility to impairment*. The lake is used for many recreational activities during all seasons since it is the largest waterbody in Alstead. In determining the lakes' recreational value, a series of questions were explored to determine the level of activity. Consideration was given for the many attributes of the lake and the particular uses by local residents and those visiting from nearby communities. Recreational value of a lake is determined by factors such as the lake's characteristics, number and type of watercraft, current and potential development in the watershed, water quality, types of recreation, and restricted use of the lake.

Lake Warren ranked moderate for recreational value based on the methodology of the NH CLI. It will be important to use this inventory and survey to establish ways in which we can maintain this level to allow a moderate level of recreational activities to occur while maintaining the health of the lake. Factors which ranked high in the recreational survey include:

- Proximity to major transportation corridors
- Lack of power boat restrictions
- Scenic or natural features of interest from a waterbody

These factors add to the attractiveness for visitors to come to Lake Warren. Changes in other factors such as water quality could also affect the usage as a recreational resource.

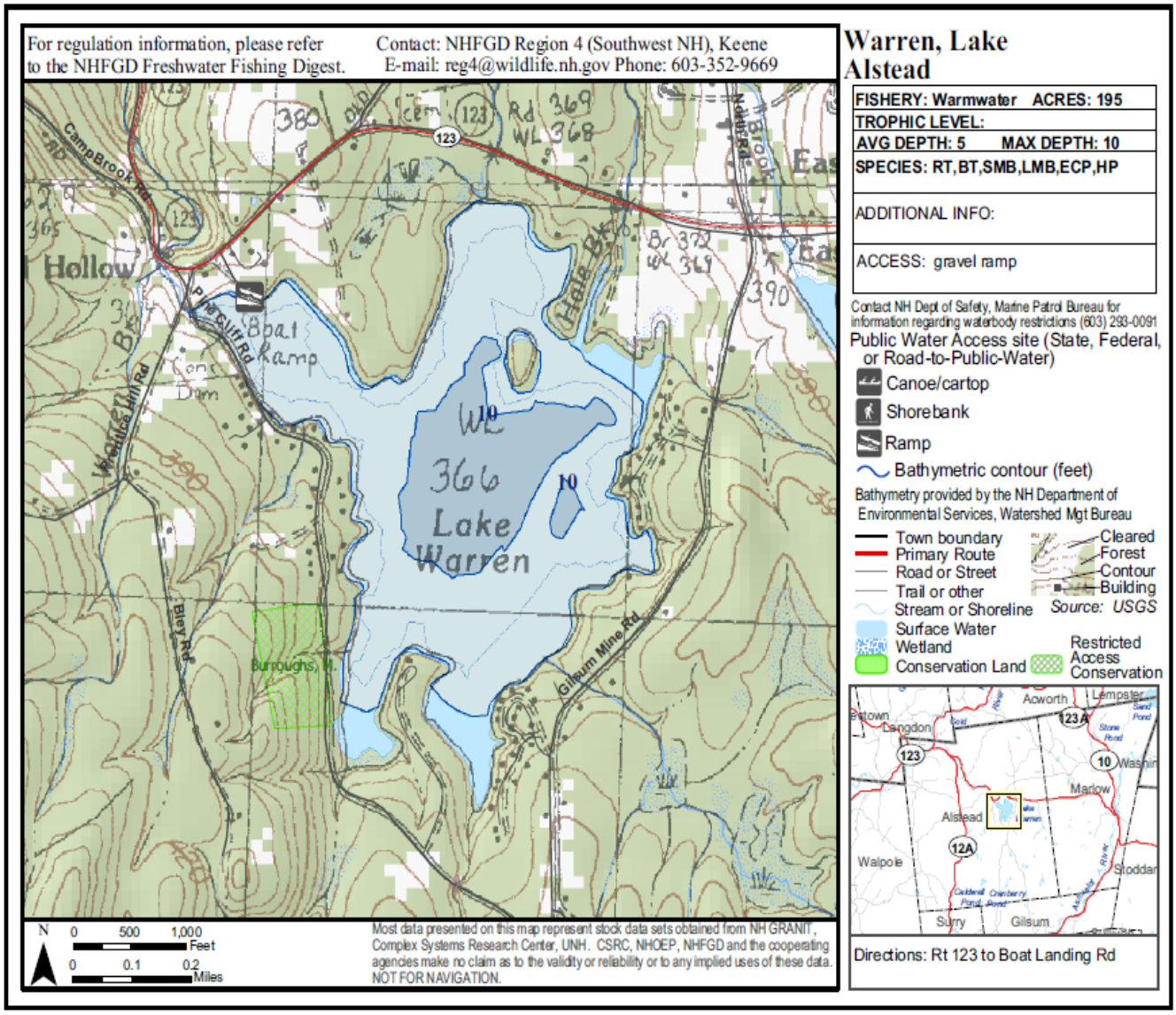
The scoring of the survey for this category can be misleading depending on an individual's perception of recreational enjoyment. Those with a desire for active recreation such as water skiing and tubing would be more favorable to a high score in many of the questions. On the other hand, those who enjoy a more passive recreational experience would most likely desire a low score on many of the questions. For this reason, the true value of the survey is in the data collection and the overall assessment gained from the process.

Photo by Lisa Tusveld

The types of recreational uses in the lake include: fishing, boating, waterskiing and tubing, swimming, and wildlife viewing. Winter recreational activities include ice fishing, skating, cross country skiing and snowmobiling. The high number of non-motorized boat users helps to reduce the desirability of motorized boats. A survey of lake front property owners showed that less that 15% of boats owned by them are motorized. A two week survey done of all boat users showed a slightly higher number of motorized boats at 23%. Lake Warren is also enjoyed by many from the shoreland. Non-water dependent activities within the watershed include: hiking, wildlife viewing and photography, biking and running.

Lake Warren is the host to a variety of educational opportunities offered by KROKA, an adventure school for children from the ages of 9 to 18 years old. Some of the academic areas that are taught include: ecology, geology, geography, cartography, meteorology, history, Native American studies, hydrology, creative writing, and nature drawing. Some of these experiences take place on the island (Map 2), which is privately owned by one of the residents who lives on the shoreline. It is hospitality like this that makes Lake Warren a special place and enhances the need for protection.

MAP 2
BATHYMETRIC MAP OF LAKE WARREN



Source: New Hampshire Fish and Game Department

ASSESSMENT OF SUSCEPTIBILITY TO IMPAIRMENT

The other portion of the survey includes the lake's *susceptibility to impairment* (as defined in the NH Comprehensive Lake Inventory) which will help us to understand the lake's vulnerability to detrimental changes. A lake with high susceptibility to impairment is one that is vulnerable to detrimental changes or impacts, or is threatened or stressed by one or more factors. When considering the lakes susceptibility to impairment, several lake attributes will help determine the risk level to water degradation.

Lake Warren ranked moderate in *susceptibility to impairment*, which supports efforts in creating a lake management plan. The areas that ranked highest for Susceptibility to Impairment are:

- Mean water depth
- Littoral zone/percent of shoal
- Secchi disc transparency
- Shoreland development and use

Lake Warren has been a member of the NH DES Volunteer Lake Program (VLAP) since 1991. VLAP is a water sampling program that is coordinated through NH DES and includes Lake Warren Associations, individual lake residents, and concerned lake visitors. It is dependent on volunteers to take water samples to assist DES in evaluating water quality. Samples are taken 2 – 3 times annually between June to August and given to the DES laboratory for analysis. Maps 3 and 4 show the locations of the monitoring stations where secchi disk transparency was determined and samples were taken to test for total phosphorus (TP), chlorophyll-a, pH, chloride, and E. coli. The information is then used to help the state determine appropriate actions if necessary to maintain the health of the lake. It is important to collect samples from the same locations in order to keep an accurate sampling record. An analogy is made between the annual reports to determine fluctuations in trophic data, and to identify trends of the information received based on the NH CLI methodology and not on evaluations of actual water quality sampling data.

The data is also used to determine the Trophic Classification. The three classifications are Oligotrophic, Mesotrophic, and Eutrophic. Lake Warren is currently listed as Mesotrophic, although it has shifted from Oligotrophic to Mesotrophic over the past three decades. Oligotrophic lakes are those lakes with the best ratings of the three classifications. They are nutrient poor which means they generally do not support algal blooms or extensive rooted plant growths. Mesotrophic Lakes are those which are a moderate classification. They may have moderate phosphorus input and water clarity compared to lakes that are Oligotrophic or Eutrophic. They are also likely to have moderate algal production. Lakes of a Mesotrophic classification may become Eutrophic if efforts are not taken to protect the lake and its watershed. Having a management plan with supportive volunteers to implement the plan will help to maintain, and potentially improve, the current Mesotrophic classification.

Sampling Results Overview

A summary report detailing the results of water sampling completed by the VLAP volunteers and NH DES is provided in Appendix B.

According to the report, stream flow, groundwater discharge and surface runoff are important contributors to water quality in the lake, and water quality in the lake in turn influences Warren Brook and the Cold River. While water quality in the lake is usually

considered acceptable relative to applicable NH DES standards and guidelines, trends observed on long-term total phosphorous (TP), chlorophyll and transparency graphs suggest that overall water quality in the lake is declining.

These declines in water quality have resulted in impairments for aquatic habitat as defined by the NH DES. If the trends continue, the lake may age prematurely and enter early-stage Eutrophic status in less than 35 years. TP is the key nutrient responsible for this situation. Increasing TP trends in the lake as well as its tributaries, culverts and outlet are a significant water quality concern for all lake stakeholders.

Prioritization of TP impacts associated with the tributaries/outlet using a set of nine qualitative and numerical criteria indicated that critical priority areas for TP management include Carmen Cove (Hale), Colburn Hill and Pickerel Brooks, and Spruce River. Several culverts on Pinecliff Road were also identified as a critical TP concern (Map 3).

Elevated specific conductance (SC) levels were observed in several of the tributaries and culverts. SC can be a good general pollution indicator. Increasing SC trends warranting further attention are occurring in Colburn Hill and Pickerel Cove Brooks.

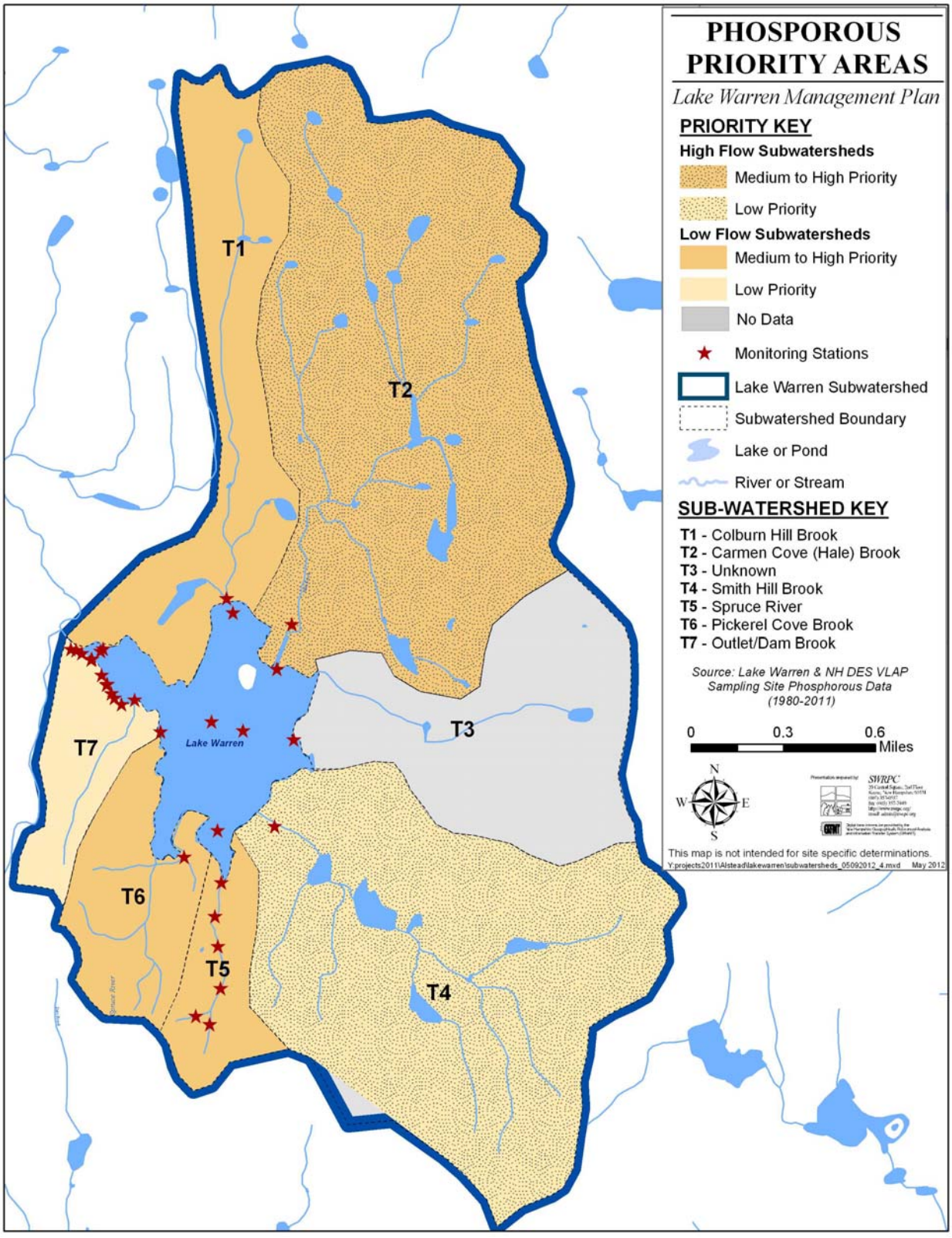
Turbidities measured in and around the lake show that suspended material levels are generally well below the applicable NH DES standard. However, excessive turbidities were measured during storms at Carmen Cove Brook and the Pinecliff Road culverts.

No violations of the NH DES chloride standard have been observed, and road salt pollution associated with chloride does not appear to be a significant water quality issue. However, Spruce River and Pickerel Cove Brook had relatively elevated chloride levels suggestive of the potential for sewerage pollution.

A number of data gaps were identified in the summary report including the need for flow data at the tributaries and outlet, identification of other tributaries that may require sampling, completion of more wet weather sampling and targeted sampling to address the culverts and tributaries with identified water quality concerns.

The Lake Warren Association is currently evaluating the findings of the summary report and planning to use the findings to help focus future sampling efforts.

Map 3
Phosphorus Priority Areas



VOLUNTEER MEMBERSHIPS AND PROGRAMS

Lake Warren Association (LWA) - The Lake Warren Association is a group of property owners surrounding the lake who, along with others interested in preserving the lake, have formed an association to help protect the lake. As of December 2011, the LWA has 118 paid members, representing approximately 70 households, consisting of both year-round and seasonal members.

New Hampshire Lakes Association - The LWA made a decision to become a member of the New Hampshire Lakes Association eight years ago. Membership of the NH Lakes Association serves as "a source of information about lakes and lake issues through educational materials, programs, and through work with state legislators". Membership also entitles the association to participate in the Lake Host Program.

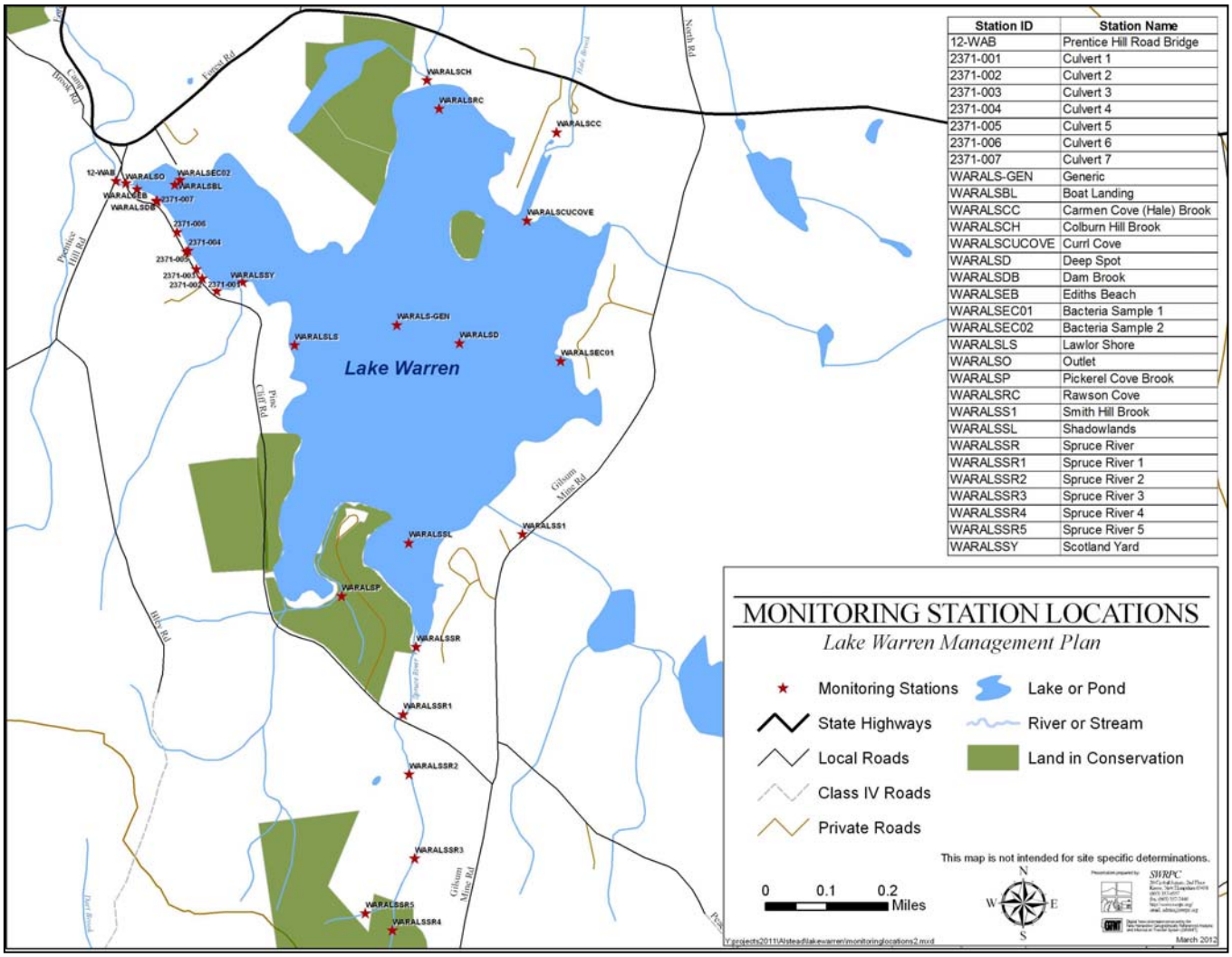
Lake Host Program - The Lake Warren Association is a participating member of the Lake Host Program and the NH DES Volunteer Weed Watcher Program. Both of these programs have been successful in helping to keep the lake free from invasive plants.

The Lake Host Program is a boat inspection program implemented by the NH Lakes Association to perform inspection of incoming boats at public boat launches for signs of exotic and invasive plants. Seeds or fragments from these plant threats can be carried from one lake to another which can spread the threat in an otherwise healthy lake. By performing an inspection of the boat and asking questions regarding the last waterbody that the boat was used in, the program helps prevent the spread and dangers that can result to lakes.

The Volunteer Weed Watcher Program - The Weed Watcher Program is a proactive approach to the control of exotic and invasive plant control. It is made up of volunteers who are trained in the identification of exotic and invasive plant species such as Variable Milfoil, Fanwort, Water Chestnut, Purple Loosestrife, and Common Reed. The team consists of eighteen members most of whom have been keeping "watch" with the program for the past eight years. Volunteers are assigned a territory and asked to conduct a monthly survey usually between May to September. If a change in plant growth is noticed, or a questionable plant is found, the volunteer reports the information to NH DES.

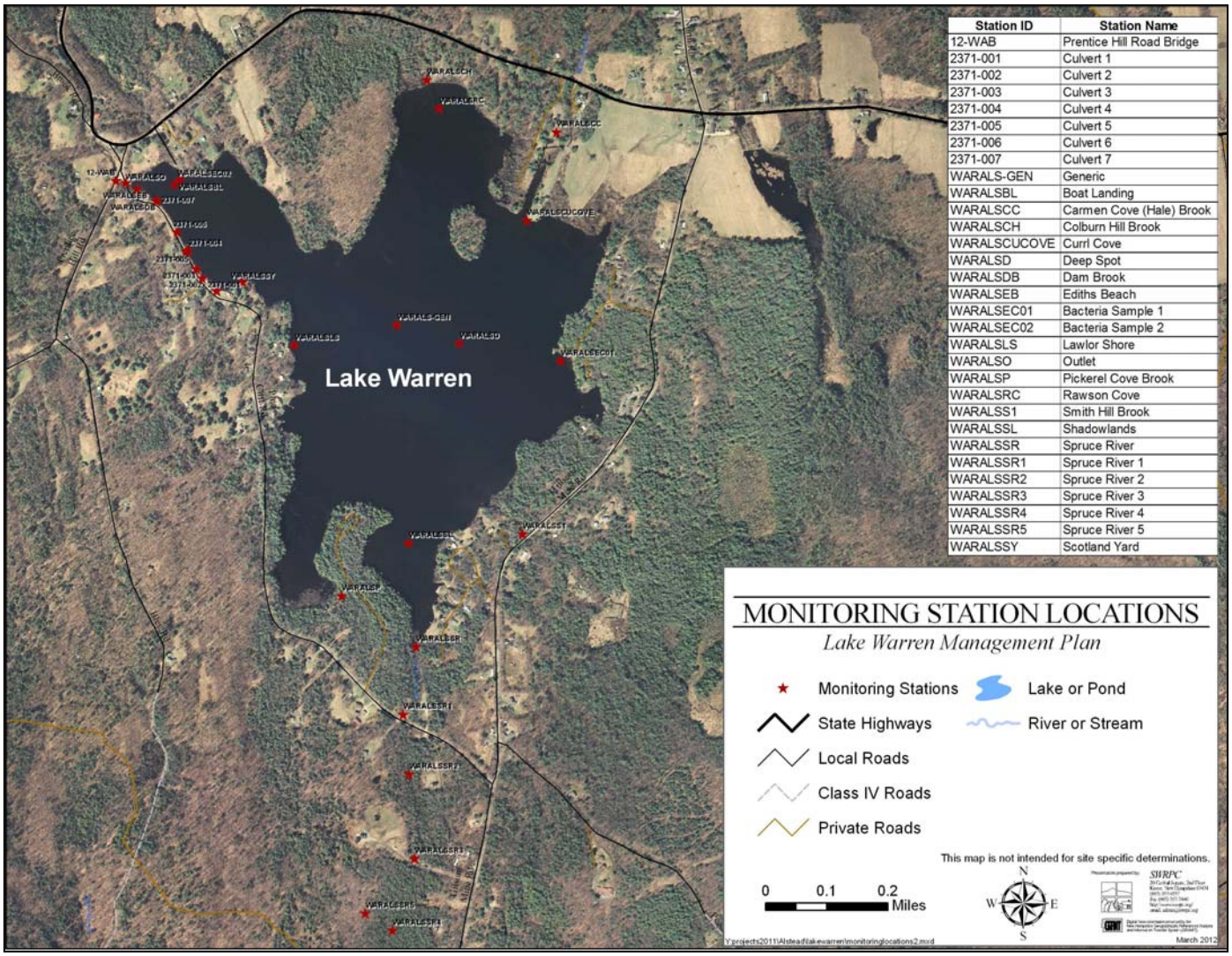
The Volunteer Lake Assessment Program (VLAP) - The Volunteer Lake Assessment Program is a cooperative program between the NH DES, lake residents and the Lake Warren Association. In this program, volunteer monitors collect water samples monthly between June and August. The sampling sites are illustrated on Maps 4 and 5. These volunteers are trained by DES to use monitoring equipment to collect lake water quality data, survey the surrounding watershed, and to sample the streams and rivers that are tributaries to the lake. The data collected is reviewed by NH DES biologists to interpret the water quality data, perform trend analyses, and compile the results into an annual report of the lake. Testing in Lake Warren first began in 1991 and has been consistently tested by volunteers for the past 13 years.

Map 4
Lake Monitoring Stations



Station ID	Station Name
12-WAB	Prentice Hill Road Bridge
2371-001	Culvert 1
2371-002	Culvert 2
2371-003	Culvert 3
2371-004	Culvert 4
2371-005	Culvert 5
2371-006	Culvert 6
2371-007	Culvert 7
WARALS-GEN	Generic
WARALSBL	Boat Landing
WARALSCC	Carmen Cove (Hale) Brook
WARALSCH	Colburn Hill Brook
WARALSCUCOVE	Curri Cove
WARALSD	Deep Spot
WARALSDB	Dam Brook
WARALSEB	Ediths Beach
WARALSEC01	Bacteria Sample 1
WARALSEC02	Bacteria Sample 2
WARALSLS	Lawlor Shore
WARALSO	Outlet
WARALSP	Pickerel Cove Brook
WARALSRC	Rawson Cove
WARALSS1	Smith Hill Brook
WARALSSL	Shadowlands
WARALSSR	Spruce River
WARALSSR1	Spruce River 1
WARALSSR2	Spruce River 2
WARALSSR3	Spruce River 3
WARALSSR4	Spruce River 4
WARALSSR5	Spruce River 5
WARALSSY	Scotland Yard

Map 5
Lake Monitoring Stations
(Aerial View)



Station ID	Station Name
12-WAB	Prentice Hill Road Bridge
2371-001	Culvert 1
2371-002	Culvert 2
2371-003	Culvert 3
2371-004	Culvert 4
2371-005	Culvert 5
2371-006	Culvert 6
2371-007	Culvert 7
WARALS-GEN	Generic
WARALSBL	Boat Landing
WARALSCC	Carmen Cove (Hale) Brook
WARALSCH	Colburn Hill Brook
WARALSCUCOVE	Curri Cove
WARALSD	Deep Spot
WARALSDB	Dam Brook
WARALSEB	Ediths Beach
WARALSEC01	Bacteria Sample 1
WARALSEC02	Bacteria Sample 2
WARALSLS	Lawlor Shore
WARALSO	Outlet
WARALSP	Pickerel Cove Brook
WARALSRC	Rawson Cove
WARALSS1	Smith Hill Brook
WARALSSL	Shadowlands
WARALSSR	Spruce River
WARALSSR1	Spruce River 1
WARALSSR2	Spruce River 2
WARALSSR3	Spruce River 3
WARALSSR4	Spruce River 4
WARALSSR5	Spruce River 5
WARALSSY	Scotland Yard

WILDLIFE IN AND AROUND LAKE WARREN

As part of a lake inventory, surveys are an important way to identify the wildlife and vegetation that add a great deal of value to our enjoyment of the lake as well as provide ecological balance to the overall health of the lake. One of the benefits of collecting this information is that it sometimes results in the identification of plants and animals that are on the Federal Endangered and Threatened Species Lists.

Endangered wildlife are those species that are native to the area, but their continued survival are in danger. A change in habitat is one of the leading causes of these species to migrate to more suitable areas. Threatened wildlife are those which have the potential of becoming endangered if measures are not taken to prevent their decline. Therefore, it is vital to protect these unique habitats.

Birds

Wildlife diversity is among one of the most outstanding features of Lake Warren. There were 71 species of birds noted in the survey taken during the summer of 2011. Among those listed, three species are on the New Hampshire Threatened Wildlife list. Survey results taken in the summer months of 2011 indicated the presence of the *Common Loon, Pied-billed Grebe, and Bald Eagle.*

The complete list of birds observed in and around the lake include:

Alder Flycatcher	Evening Grosbeak	Pileated Woodpecker
American Bittern	Flicker	Pine Grosbeak
American Crow	Gold Finch	Purple Finch
Bald Eagle	Great Blue Heron	Raven
Baltimore Oriole	Great Horned Owl	Red Breasted Nuthatch
Barn Swallow	Hairy Woodpecker	Red-eyed Vireo
Barred Owl	Hermit Thrush	Redpoll
Belted Kingfisher	Hooded Merganser	Red Shouldered Hawk
Black-capped Chickadee	House Finch	Red-winged Blackbird
Blue Jay	Junco	Robin
Blue-winged Teal	Kestrel	Ruby Throated Hummingbird
Bobolink	Killdeer	Scarlet Tanager
Bohemian Waxwing	Kingbird	Song Sparrow
Bonaparte Gull	Least Flycatcher	Spotted Sandpiper
Broad-winged Hawk	Mallard	Tree Swallow
Canada Goose	Marsh Wren	Tufted Titmouse
Catbird	Maryland Yellowthroat	Turkey Vulture
Cedar Waxwing	Mourning Dove	Warbling Vireo
Common Grackle	Northern Rough-winged Swallow	White Breasted Nuthatch
Common Loon	Northern Three-toed Woodpecker	Wild Turkey
Common Merganser	Osprey	Wood Duck
Common Yellowthroat	Ovenbird	Wood Thrush
Cormorant	Palm Warbler	Yellow Warbler
Downy Woodpecker	Pied Billed Grebe	Yellow Bellied Sapsucker

Photo by Philip Sanford

In addition to the many types of birds identified, surveys were also taken of mammals, reptiles and amphibians. None of those identified are on the New Hampshire Endangered or Threatened Lists.

Mammals

Habitat management is critical to the survival and enjoyment of our four-legged friends that call the watershed "home." A diverse age and variety of trees and other vegetation is an essential part of wildlife habitat. Protection of these habitats will help to provide a healthy environment for them to remain in the area. There were 22 mammals found within the lake's watershed area.

Bear	Ground Hog	River Otter
Beaver	Snowshoe Hare	Porcupine
Eastern Chipmunk	Mink	Rabbit
Coyote	Star-nosed Mole	Grey Squirrel
Deer	Moose	Red Squirrel
Grey Fox	Muskrat	Flying Squirrel
Red Fox	Opossum	
Skunk	Raccoon	

Fish, Reptiles and Amphibians

Aquatic habitats are very fragile and require unique conditions for a healthy variety of fish, reptiles and other amphibians. Among the criteria that meet the needs of these ecosystems are water quality and temperature, and vegetation. Lake Warren is the home to many species that live in and along the shoreline. Members of the Lake Warren Management Plan Committee and lake front residents surveyed the lake and surrounding area to identify the fish, reptiles and amphibians as part of this inventory and identified the following:

Reptiles and Amphibians

Reptiles and amphibians noted in the survey include: Eastern Painted Turtle, Snapping Turtle, Bullfrog, Grey Treefrog, Green Frog, Northern Leopard Frog, Pickerel Frog, Wood Frog, American Toad, Spring Peeper, Spotted Salamander, Red-spotted Newt, Eastern Ribbon Snake, and Red Bellied Snake.

Fish

There is a wide variety of fish species found in Lake Warren. According to New Hampshire Fish and Game Department and responses from a survey of lakefront property owners, the following fish have been identified:

Common Sunfish	Rainbow Trout
Largemouth Bass	Brown Trout
Smallmouth Bass	Black Crappie
Yellow Perch	Brown Bullhead
Pumpkinseed	Golden Shiner
Bluegill	Horned Pout
Pickerel	

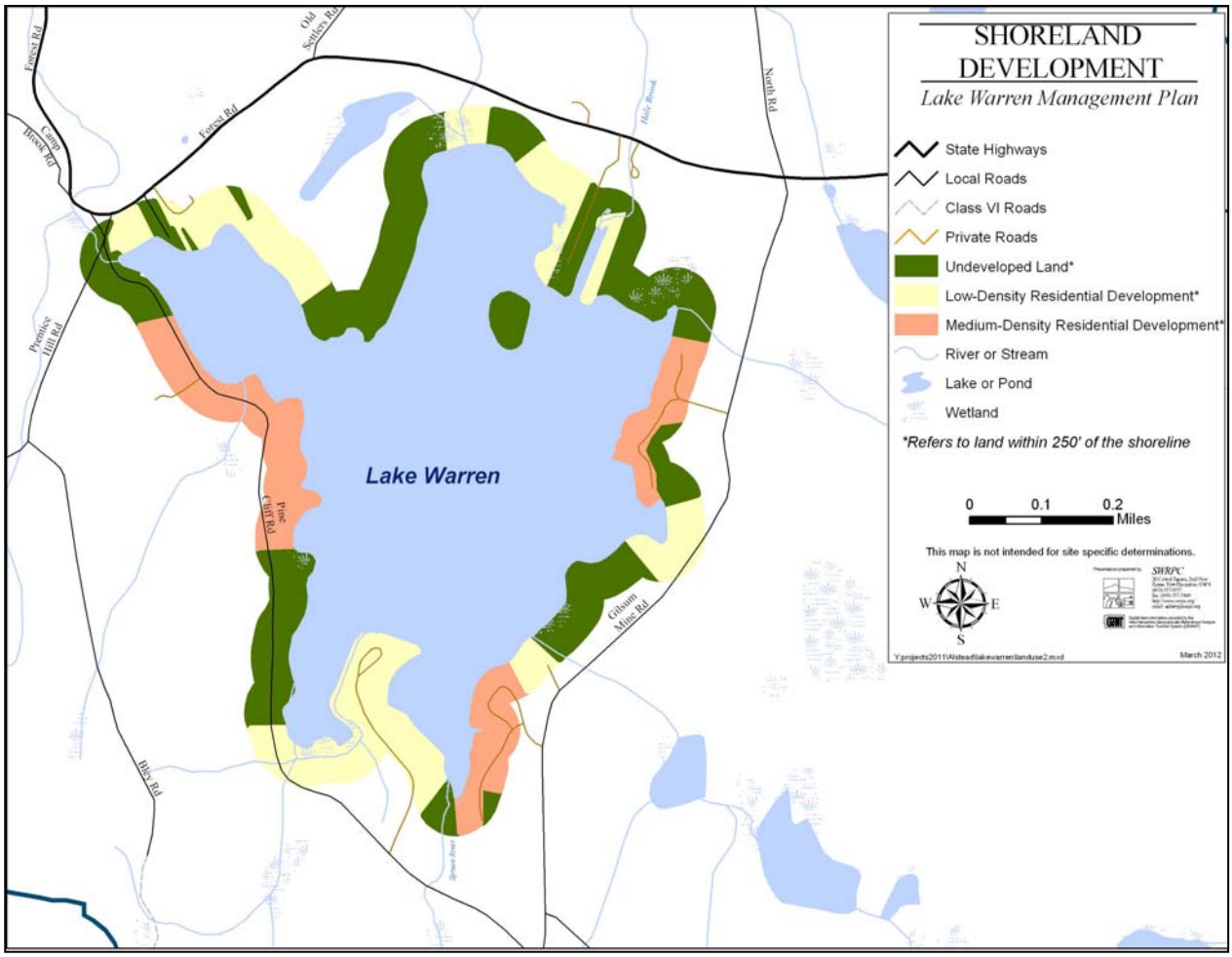
LAND USE AND DEVELOPMENT

The Town of Alstead has established a Lake District which encompasses all land within the following boundaries: Beginning at Mill Hollow, the boundary follows Route 123 to the junction of Gilsum Mine Road. The boundary continues south on Gilsum Mine Road to a point 500' south of the junction of Pine Cliff Road where it turns westerly and parallels Pine Cliff Road at a distance of 500' south and west of the road to the junction of Route 123 in Mill Hollow. The Lake District is all land within these boundaries.

This district was created to preserve the special quality and character of Lake Warren by protecting the natural environment, water quality, and visual beauty, and historic features of the lake through zoning restrictions. The uses that are permitted in the district are very limited. Residential uses, and accessory or complimentary uses, are the only uses permitted under the current Zoning Ordinances. Although this limits the types of uses, best management practices need to be implemented for any use to effectively protect the lake.

Map 6 shows the shoreland development and the land use in terms of low density, medium density and undeveloped areas. The shoreland area is the land area within 250’ of the lakes’ shoreline. The total shoreland area for Lake Warren is 5,268,458 square feet. Of that, 44% (or 2,318,320 sq. ft.) is currently undeveloped, which could have a significant impact on the lake if development occurs. Putting land in conservation will be an important measure to protect the lake and shoreland area. Other effective methods include the implementation of low impact development restrictions, best management practices, and outreach and education for landowners and lake users.

Map 6
Shoreland Development and Land Use



Shoreland Development and Land Use

Land Use Type	*Land Area (Square Feet)*	% of Shoreland Area*
Medium Density	1,191,530	22.62
Low Density Development	1,758,608	33.38
Undeveloped	2,318,320	44.00
Total Shoreland Area	5,268,458 Square Feet	

**The Shoreland Area is all land within 250' of the Shoreline*

Protected Land and Land Ownership

Land protection around the lake is vital to continue the health of the lake and the diversity of wildlife species that are present. Additionally, stewardship of land in conservation and proper

usage of privately owned land is also important. Mapping the ownership of the lakeshore properties and the conservation areas is a useful tool for creating a lake management plan. In preparing the Lake Warren Management Plan, these areas were mapped according to data collected from the Alstead parcel data.

Map 7 depicts land ownership and protected land within the shoreline buffer (250' of the shoreline).

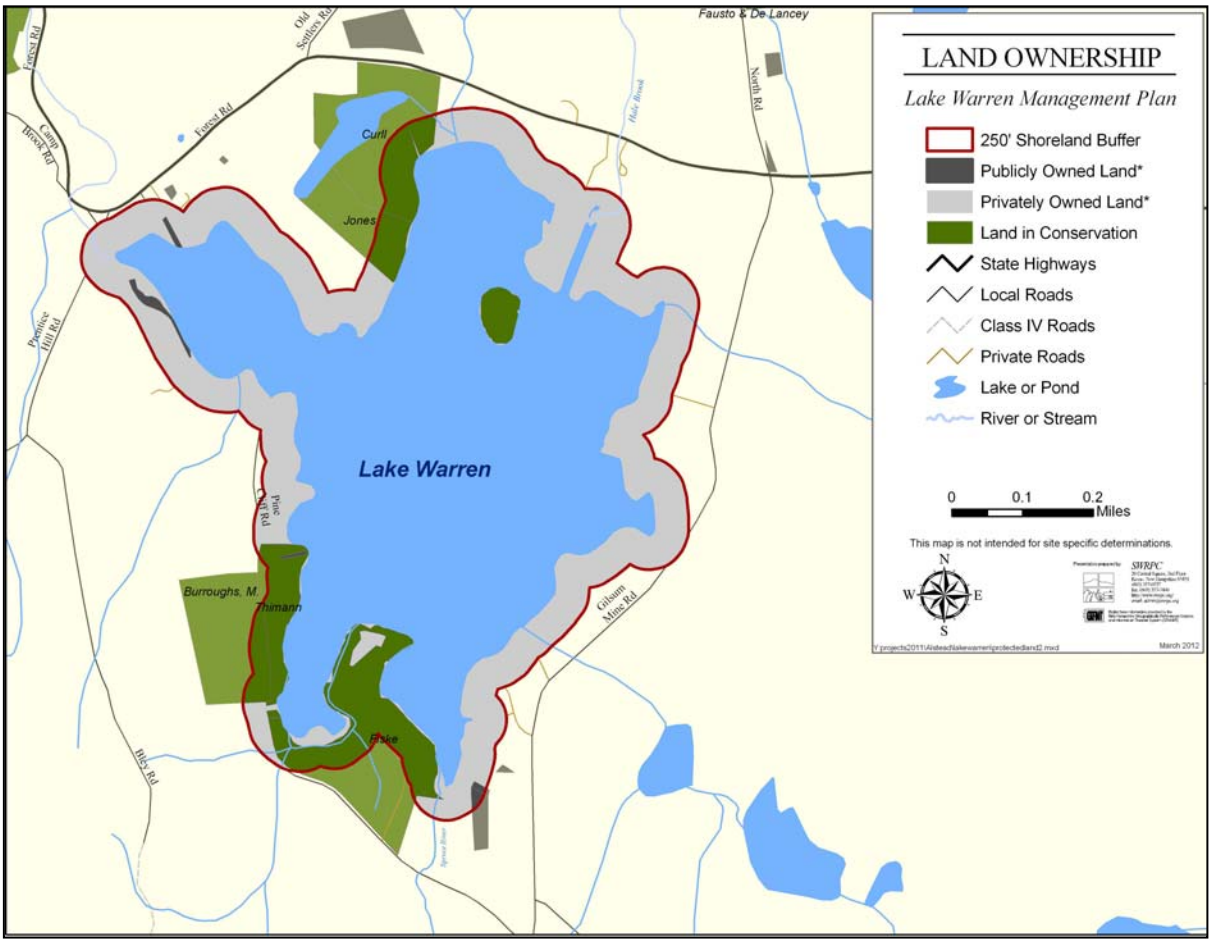
The chart below shows that 73.22% (3,857,758 sq. ft.) of this land is privately owned land that is not in conservation status. Another 25.53% (1,344,859 sq. ft.) is privately owned land in conservation, while the remaining 1.25% (65,843 sq. ft.) is publicly owned land and is used as the boat ramp.

Protected Land and Land Ownership

Land Use Type	***Land Area (Square Feet)***	**% of Shoreland Area***
Publicly Owned Land	65,843	1.25
Private Land in Conservation	1,344,859	25.53
Privately Owned Land Not in Conservation	3,857,758	73.22
Total Shoreland Area	**5,268,458**	

Photo by Ellen Chase

Map 7
Protected Land and Land Ownership



**The Shoreland Area is all land within 250' of the Shoreline*

Management Goals, Objectives and Actions

The preparation of a Lake Management Plan is an evolving process that takes on many shapes during development. No plan is complete without having a set of goals to work towards with objectives and actions to get there. The Lake Warren Management Committee developed the goals, objectives, and actions in this section through several public meetings to help determine the needs of maintaining a healthy, active lake. These may be modified through the upcoming years as different issues and concerns arise. An annual review should be performed to check the status of the existing Goals and Objectives, and to consider additional ones that should be added.

Goal 1: To oversee the implementation of this Management Plan and build partnerships that will support actions established herein.

Objectives:

1. Establish subcommittees to perform actions effectively and efficiently.
   Recommendations for future actions:
   a. Establish the following committees to implement the goals and actions identified within this Plan: VLAP Committee, Outreach/Planning Committee, Swimming Area Committee, and Historic Committee. Chairs of the Weedwatcher and Lake Host Program should be a part of the Outreach/Planning Committee.

2. Establish partnerships that will support efforts contained within this Plan.
   Recommendations for future actions:
   b. Designate a member of the Lake Warren Management Committee to foster strategic partnerships with local, regional and state groups that share a common interest with the LWA, including but not limited to the Alstead Conservation Commission, Cold River LAC, Monadnock Conservancy, etc. Utilize NH DES-Water Division for information to complete this action.

Goal 2: Protect and improve **water quality** for current and future users.

Objectives:

1. Continue the water sampling through the VLAP program to monitor the health of the lake.
   Recommendations for future actions:
   a. Continue to implement the water quality protection recommendations provided by NH DES in their annual VLAP reports. Maintain and increase support for the ongoing VLAP sampling program to monitor water quality trends.
   b. Train additional volunteers that can do the samplings if designated samplers are unable to take the scheduled testing.
   c. Seek funding to hire a consultant to complete a nutrient loading study, including the collection of additional stream flow data, incorporation of

historical concentration data and consideration of non-assessed sub-watersheds.

Recommendations for future Water Quality Testing (not necessarily in order of importance):

d. Initiate targeted investigations of critical priority areas for TP management using the phased approach, including windshield/stream surveys, site visits, bracket sampling and/or storm sampling to identify specific pollution sources.
e. Develop a target for in-lake TP concentration, Secchi disk transparency and chlorophyll content, based on desired uses and the relation among these variables for the lake. Initiate targeted investigations of subwatersheds where adverse concentrations or trends of SC, turbidity and chloride were identified.
f. Expand the existing sampling program to include rain events. Substitute one wet weather event for one of the routine summer tributary sampling rounds.
g. Explore restoration of vegetation buffer on Pine Cliff Road where it has been widened by grading.
h. Verify drainage patterns in the vicinity of the dam and also on the upper reach of Gilsum Mine Road. Modify the tributary sampling approach if needed.
i. Consider adding regular water level, temperature and DO monitoring to the tributary sampling program.
j. Further examine the type of algae that are dominant in the lake and seasonal algae changes. Discuss expected dominance of algae vs. rooted vegetation. Continue to monitor for the presence of the so-called toxic blue-green algae.
k. Include two or more additional plankton samplings.

2. Provide outreach and education to property owners within the watershed about stormwater management methods and other practices that can help with maintaining water quality.

Recommendations for future actions:

a. Prepare a packet of information to be distributed to property owners within the watershed including information on stormwater management methods, permitting requirements, contacts for Lake Warren Association, Alstead Board of Selectmen, Alstead Conservation Commission and NH DES. The Lake Warren Outreach/Planning Committee should collect outreach material and determine the method of distribution.
b. Investigate the possibility of involving the NH Lakes Association, Conservation Corps Program for a restoration project or other project. Designate a representative of the Lake Warren Association to contact the NH Lakes Association to begin the process.
c. Continue pursuing and promoting a discounted septic pump-out program to encourage regular pump-outs for waterfront and watershed homes. Encourage waterfront and stream-side owners to avoid vegetated buffer removal and direct drainage to water.
d. Work with the Town's yet to be named Open Space Committee to initiate or continue discussions with large property owners in the watershed regarding land conservation benefits/opportunities.
e. Work with the Conservation Commission to continue providing public outreach/education about lake health, land stewardship and best management practices (BMPs) for water quality protection. Work with schools, camps,

and other youth organizations like the Boy and Girl Scouts to involve children and youth groups to the extent possible, as well as recreational users and the Town. Take advantage of the many excellent NH DES water quality and BMP fact sheets.

3. Provide outreach and education to increase awareness of, and encourage compliance with the Shoreland Water Quality Protection Act (SWQPA).
   Recommendations for future actions:
   a. Invite a representative from NH DES to give an informative presentation on the current requirements of the SWQPA. The Lake Warren Outreach/Planning Committee should plan and publicize the event.
   b. Utilize the Lake Warren Association newsletter to promote this goal by providing useful information, and stories about other lakes, etc.
   c. Develop a plan to encourage compliance that maximizes the prospects for ultimate success. This should emphasize a mechanism for reporting problems to a non-enforcement group, education, and diplomacy perhaps on a neighbor to neighbor basis based on the assumption that most will want to do the right thing for the lake and its environs. The Alstead Conservation Commission may be a resource for this action.

4. Initiate a signage program that identifies the Lake Warren watershed area as people are entering the area.
   Recommendations for future actions:
   a. Designate a member of the Lake Warren Management Committee to contact the Zoning Officer for support of this effort.
   b. Contact NH DES-Water Division for information to complete this action.

Goal 3: Protection of wildlife and aquatic **habitat**.

Objectives:

1. Create a database of nesting areas and sensitive wildlife habitats within the watershed.
   Recommendations for future actions:
   a. Have volunteers from the Lake Warren Association, Conservation Commission, users of the lake, community members and other interested parties, walk the area and identify sensitive areas that support wildlife habitat. Recruit local experts that are experienced in wildlife habitats to assist in identifying these areas.
   b. Incorporate data collected into this Management Plan and report it to the keepers of the NH Wildlife Action Plan. Also share this information with the Loon Preservation Committee and the NH Audubon Society. Designate an individual to submit this information to the appropriate organizations.

2. Help create awareness of habitats that are significant to the breeding, nesting, and overall ecological importance to the life cycles of wildlife and aquatic species.
   Recommendations for future actions:
   a. Establish a core group of volunteers to prepare materials to educate landowners and lake visitors of the benefits of protection of these habitats. Include pictures to help in the identification and education of the species and

their habitats. The Alstead Conservation Commission may serve as a resource for this action.

3. Hold a series of educational public events on wildlife and their habitats.
   Recommendations for future actions:
   a. Organize public forums and clean-ups involving participation of municipal officials, landowners and lake users to raise awareness about the importance of habitat protection. The Alstead Conservation Commission may be a resource to assist in this action.
   b. Distribute information regarding wildlife habitats and protection at public events and at the Town Offices. Assemble outreach material and determine the method of distribution.

4. Monitor the health of the fish within the lake.
   Recommendations for future actions:
   a. Develop and maintain contact with the NH Fish and Game Department to help protect and improve the fishery.
   b. Invite a representative of the NH Fish and Game Department periodically to educate fishermen and lake enthusiasts about the fishery.

Goal 4: Protect Lake Warren and the watershed against **invasive species**.

Objectives:

1. Continue to participate in the Lake Host Program.
   Recommendations for future actions:
   a. Increase volunteerism to cover additional times throughout the summer months. The Lake Warren Outreach/Planning Committee should collect outreach material to explain the work of the Lake Host Program and encourage others to volunteer time to check incoming boats.

2. Provide outreach and education to property owners around the lake, and users of the lake, about the spread of invasive species and the negative effects they can have on the lake.
   Recommendations for future actions:
   a. Distribute information on the identification of invasive species to landowners and with the Lake Host check-ins. This can be included in the information packet in Goal 2.

3. Increase the number of Weed Watcher volunteers.
   Recommendations for future actions:
   a. Promote awareness and provide information at the Lake Warren Association meetings about the Weed Watcher Program and encourage individuals to be aware of invasive species when they are boating or hiking in and around the lake.
   b. Provide information on how to get involved in becoming a Weed Watcher. The Lake Warren Outreach/Planning Committee should collect outreach material to explain the work of the Weed Watchers and encourage others to volunteer time to keep watch.

Goal 5: Preserve the **rural character** of the lake and the surrounding area.

Objectives:

1. Consider the ecology of the lake as further developments are proposed within the watershed.

   Recommendations for future actions:

   a. Work with the yet to be named Town Open Space Committee to seek grant opportunities to secure undeveloped parcels through ownership or conservation easements. Identify potential parcels that would be beneficial to be put into conservation status. Designate a subcommittee of the Lake Warren Management Plan Committee for this purpose.

2. Protection of the island from erosion caused by the wake from motorboats.

   Recommendations for future actions:

   a. Raise awareness about the effects of erosion caused by the wake of fast motorboats. Distribute and post information obtained from NH DES and NH Lakes Association. Also include information in the Lake Warren newsletter.
   b. Seek assistance from the NH Lakes Association Conservation Corps, KROKA, Scouting troops and the like to help protect the shoreline from erosion.

3. Preserve the lake's history.

   Recommendations for future actions:

   a. Work with the Alstead Historical Society to document the history of the lake. Make this information available on the Town's website and consider creating a Lake Warren website. Request assistance from Lake Warren Association members and town residents to provide stories and pictures to be included. The Lake Warren Historic Committee may be a resource to help collect information and promote this action.

4. Maintain sustainable use of the resources.

   Recommendations for future actions:

   a. Promote the preservation and continued enjoyment of the lake through best management practices and conservation efforts. Include a list of Best Management Practices in the information packet to be distributed to property owners within the watershed. This information could be added to the packet in Goal 2.
   b. Work with the Alstead Planning and Zoning Boards to perform a thorough review of Alstead's Master Plan, Zoning Ordinances, Subdivision and Site Plan Regulations for opportunities to add protection to all waterbodies in Alstead. Designate a member or subcommittee of the Lake Warren Management Plan Committee to serve as liaison and report back to the full Committee. Determine appropriate changes in concert with the appropriate Alstead Boards or Commissions. Maintain contact with the Planning Board, Zoning Board of Adjustments, and Conservation Commission and seek to be informed of any meetings where the lake might be affected.

c. Work with Alstead Planning Board and Conservation Commission to better understand the state of the Town's regulations with regard to the discouragement of impervious surfaces and encouragement of on-site storm water disposal.

Goal 6: Maintain and improve **recreational access** and encourage safe and responsible use of the lake and its resources.

Objectives:

1. Promote and encourage safe and responsible boating practices for all types of watercraft and all levels of user abilities.
   Recommendations for future actions:
   a. Invite a representative from Marine Patrol to come to give a presentation on safe and responsible boating practices. The Outreach/Planning Committee should plan and publicize the event.

2. Explore the feasibility of a limited swimming area.
   Recommendations for future actions:
   a. Appoint a subcommittee of the Lake Warren Management Plan Committee to explore this objective.

3. Create awareness of potential conflicting recreational uses and ways to coexist.
   Recommendations for future actions:
   a. Promote respect of others enjoyment of the lake and its surroundings through outreach material from sources such as the NH Lakes Association, NH DES, and the UNH Cooperative Extension Programs.

Goal 7: Increase **volunteerism and advocacy** in all aspects of protecting the lake and natural habitats within the watershed.

Objectives:

1. Promote this plan to the Lake Warren Association members and citizens of the town in order to gain acceptance and support of its goals.
   Recommendations for future actions:
   a. Provide a copy of the Comprehensive Lake Inventory and Management Plan to the Alstead Town Office for public display. Designate a member of the Lake Warren Management Plan Committee to complete this action.
   b. Present this Plan to the Conservation Commission and the Planning Board. Request that it be incorporated into the Alstead Master Plan.

2. Expand membership in the Lake Warren Association to include more lake abutters.
   Recommendations for future actions:
   a. Establish a membership committee to put together a packet of information to potential new members and distribute by personal delivery or mailing.

3. Encourage participation in the Lake Warren Association committees.
   Recommendations for future actions:
   a. Include information in the Lake Warren newsletter about the various committees of the Lake Warren Association. Encourage the chairperson of

each committee to add a description of their committee including recent activities and goals.

APPENDIX A

ASSESSMENT RESULTS OF RECREATIONAL VALUE

RECREATIONAL VALUE ATTRIBUTE AND ASSOCIATED QUESTIONS	RESPONSE	RECORDED POINTS	POSSIBLE POINTS
ATTRIBUTE 1. GEOGRAPHIC, SPATIAL, AND DEMOGRAPHIC INFORMATION			
C. Proximity to major transportation corridors		4	5
D. Total year-round resident population within 30-mile radius		1	5
ATTRIBUTE 2. PHYSICAL WATERBODY CHARACTERISTICS			
A. Surface water area		2	5
E. Shoreline configuration/shape		2	5
F. Island Presence/absence	1	2	5
ATTRIBUTE 3. WATER QUALITY CHARACTERISTICS			
F. Secchi disc transparency	2.3 meters	2	5
ATTRIBUTE 4. BIOLOGICAL/ECOLOGICAL CHARACTERISTICS			
A. Algal abundance	7.49	3	5
H. Specialized habits, breeding, or rearing areas		1	5
ATTRIBUTE 5. RECREATIONAL CHARACTERISTICS			
A. Type of watercraft use		4	5
B. Average watercraft density on lake	20.6	3	5
C. Private marine service/docking facilities	0	1	5
E. Recreational fishing	6 species/warm	2	5
F. Fishing tournaments/derbies	0	1	5
G. Angler usage	1 angler/<4 acre	5	5
K. Boat launches and access sites	1	2	5
L. Other recreation and support facilities	0	1	5
ATTRIBUTE 6. RESTRICTIONS OR PROHIBITED USES			
E. Power boat restrictions	none	5	5
F. Ski craft restrictions	prohibited	1	5
ATTRIBUTE 9. Watershed Characteristics			
A. Watershed development and land use		4	5
ATTRIBUTE 10. VISUAL/AESTHETIC CHARACTERISTICS			
A. Scenic or natural features of interest visible from waterbody	>3	5	5
TOTAL		**51**	**100**

ASSESSMENT OF SUSCEPTIBILITY TO IMPAIRMENT

SUSCEPTIBILITY TO IMPAIRMENT ATTRIBUTE AND ASSOCIATED QUESTIONS	RESPONSE	RECORDED POINTS	POSSIBLE POINTS
ATTRIBUTE 1. GEOGRAPHIC, SPATIAL, AND DEMOGRAPHIC INFORMATION			
D. Total year-round resident population within 30-mile radius		3	5
ATTRIBUTE 2. PHYSICAL WATERBODY CHARACTERISTICS			
C. Mean water depth (feet)		4	5
D. Percent shoal area/littoral zone		5	5
I. Watershed area/lake area ratio	17.45	2	5
J. Hydraulic flushing area	4.2/yr	1	5
ATTRIBUTE 3. WATER QUALITY CHARACTERISTICS			
A. Waterbody trophic status	mesotrophic	3	5
E. Total phosphorus concentration	.010-.018mg/L	4	5
F. Secchi disc transparency	2.3 meters	4	5
I. Historic point source discharges		1	5
ATTRIBUTE 4. BIOLOGICAL/ECOLOGICAL CHARACTERISTICS			
A. Algal abundance	7.49	3	5
I. Exotic aquatic plant species		1	5
J. Exotic aquatic animal species		1	5
ATTRIBUTE 5. RECREATIONAL CHARACTERISTICS			
A. Type of watercraft use		2	5
B. Average watercraft density on lake	20.6	3	5
ATTRIBUTE 8. SHORELAND CHARACTERISTICS			
A. Shoreland development and use	59.05%	4	5
D. Percent of impervious surface	6.7%	3	5
H. Local land use regulatory measures within the shoreland		2	5
ATTRIBUTE 9. WATERSHED CHARACTERISTICS			
A. Watershed development and land use		2	5
D. Protected Land/Unavailable w/in watershed		4	5
H. Local land use regulatory measures		3	5
TOTAL		**55**	**100**